Influence of Nitrogen Fertility on the Susceptibility of Rhododendrons to *Phytophthora ramorum*

Rita L. Hummel, Marianne Elliott, Gary Chastagner, Robert E. Riley, Kathy Riley, and Annie DeBauw
Washington State University, Puyallup, WA 98371; klriley@wsu.edu

Introduction

Research information demonstrating the effects of various cultural practices on host susceptibility to *Phytophthora ramorum* is generally lacking and thus limits the development of an integrated approach to managing diseases caused by this pathogen in irrigated nursery systems. Because rhododendrons and azaleas have accounted for about 90% of the plants associated with *P. ramorum*-positive nursery finds in Washington State (as well as being the most important hosts of *P. ramorum* in Europe), their management in an irrigated nursery environment is critical to controlling the spread of this pathogen (1). Nitrogen fertility levels have been reported to increase disease levels in some *Phytophthora* pathosystems, but no data is available for the *P. ramorum*-rhododendron pathosystem.

Methods

During 2008 we investigated the dynamics between nitrogen application rates and the susceptibility of rhododendron cultivars 'English Roseum', 'Cunningham's White' and 'Compact P.J.M.' to *P. ramorum*. Plants had been grown in 3-gallon containers in a medium of 100% Douglas-fir bark with Micromax™ incorporated at the rate of 1.75 lbs/yd3, placed on a gravel nursery bed, and watered as needed with overhead sprinkler irrigation. Before beginning the experiment, residual fertilizer in the media was depleted and three treatments of ammonium nitrate fertilizer at 100, 300 and 600 ppm N was applied in liquid form twice a week to each of eight plants per cultivar starting on June 2. With each nitrogen fertilization, phosphorus in the form of potassium phosphate (100 ppm) and potassium in the form of potassium sulfate (200 ppm) were applied. Commencing with fertilizer application, the plants were switched to a drip irrigation system. In early October, plant growth, visual quality and leaf color were measured (Figure 1). At the same time, two sets of fully mature, current season leaves from each plant were harvested for 1) determination of leaf tissue nitrogen content and 2) *P. ramorum* inoculations.

Six detached leaves from each plant were inoculated with zoospores from an NA1 lineage rhododendron isolate of *P. ramorum* (03-74-N10A-A, from *R.* x 'Unique') by pipetting a 10 µl drop of suspension with 568,000 zoospores/ml onto the lower leaf surface. The leaf tissue beneath drops on three leaves was wounded using an insect pin, while the tissue beneath each drop on the other leaves was left unwounded. Leaves were incubated in Petri plates with moist filter paper in the dark at 19-20 C for 10 days.

Results

As expected, foliage color, shoot growth, plant quality indices and foliage nitrogen levels increased with nitrogen fertility (Figure 1 and Tables 1 and 2). Observed leaf color correlated with measured leaf color and plants given higher rates of N were greener than those fertilized at lower rates. Fertility had no effect on root length or density. Foliar nitrogen concentration increased with nitrogen rate. Based on an overall analysis of lesion size after 10 days, there was a significant difference in the susceptibility of the three cultivars to *P. ramorum*. "Compact P.J.M.' had the smallest lesions, while 'English Roseum' had the largest (Table 2 and Figure 2). Lesions developed on all the wounded and unwounded inoculation sites on the 'English Roseum' and lesion size increased with increasing nitrogen fertility. Nitrogen fertility had no effect on lesion size on the other two cultivars.

Figure 1. Potted Rhododendron 'Compact PJM', 'Cunningham's White', and 'English Roseum' with three levels of N fertilization.

Table 1. Effect of nitrogen fertility level on Rhododendron leaf color.

Nitrogen Rate (ppm)	L*	Hue Angle	Chroma
'Cunningham's White'			
600	34.4 A	129.7 A	15.6 A
300	38.8 B	125.3 B	24.0 B
100	53.6 C	110.6 C	46.3 C
'English Roseum'			
600	38.1 A	127.7 A	22.3 A
300	42.7 B	123.3 B	30.9 B
100	51.9 C	116.0 C	44.0 C

In fall 2009, color of the adaxial (upper) leaf surface of two mature leaves from the most recent growth flush was determined quantitatively with a Minolta CR200b Chroma Meter (Minolta, Ramsay, N. J.). The CIELAB coordinates, L*a*b*, were recorded and the chroma (C*) and hue angle (h°) were calculated (3). L* measures the lightness or value of the color from black (equal 0) to white (equal 100). C* is the degree of color from grey (equal 0) to pure chromatic color and h° is the attribute of color perceived (0° = red, 90 ° = yellow, 180 ° = green, and 270 ° = blue or intermediate between adjacent pairs arranged on a 360° color wheel). Cultivar 'Compact PJM' not measured because of red coloration in leaves.

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Table 2. Rhododendron shoot growth index (SGI), shoot quality, root length, root density, per cent total nitrogen in the leaves, and size of *P. ramorum* lesion on unwounded leaves.

Nitrogen Rate (ppm)	SGI (cm)	Shoot Quality	Root Length	Root Density	% Total Nitrogen	Lesion (mm^2)
'Compact PJM'						
600	14.1A	3.8A	3.0A	2.8A	1.63A	10A
300	12.1AB	3.3A	3.0A	2.9A	1.44B	2A
100	6.5B	2.5B	3.0A	2.8A	1.24C	8A
'Cunningham's White'						
600	7.3A	4.4A	3.0A	3.0A	1.64A	200A
300	5.0B	4.5A	3.0A	3.0A	1.17B	217A
100	4.4B	3.0B	3.0A	3.0A	0.72C	176A
'English Roseum'						
600	11.2A	4.6A	3.0A	3.0A	1.25A	660 A
300	7.1B	3.8B	3.0A	2.9A	1.03B	456 B
100	4.5B	2.6C	3.0A	2.9A	0.76C	347 C

SGI=((widest width + narrowest width)/2 + height)/2.
Shoot quality was rated on a 1 to 5 scale where 5 = superior, 1 = poor and a rating of 3 was considered marketable.
Root length was rated from 1 to 4 where 1 = roots grew 1/2 to container bottom and 4 = roots circling bottom container.
Root density was rated from 1 to 4 where 1 = no roots visible at rootball periphery and 4 = solid root mass with little or no growing medium visible.
Cultivar means followed by the same letter are not significantly different at the 5% level using Tukey's studentized range test.

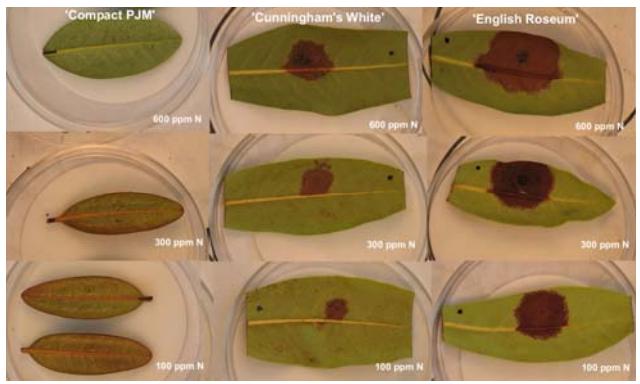

Figure 2. Detached leaves of Rhododendron cultivars with three levels of N fertilization inoculated with *P. ramorum*. The wound-inoculated treatment is shown here.

Selected References

1. Dart, N.L. and G.A. Chastagner. 2007. Estimated economic losses associated with the destruction of plants due to *Phytophthora ramorum* quarantine efforts in Washington State. Online. Plant Health Progress doi:10.1094/PHP-2007-0508-02-RS.
2. Halsall, D.M., R.I. Forrester, and T.E. Moss. 1983. Effects of nitrogen, phosphorus and calcium nutrition on growth of eucalypt seedlings and on the expression of disease associated with *Phytophthora cinnamomi* infection. Aust. J. Bot. 31:341-355.
3. McGuire, R.G. 1992. Reporting of objective color measurements. HortSci. 27:1254-1255